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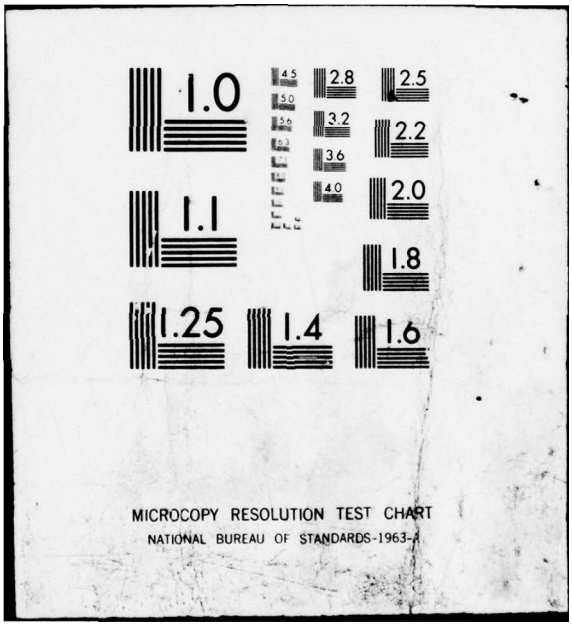
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TR 78-30
(REVISED)

LEVEL III

AIRCRAFT RAM (MMH/FH) DATA COMPARATIVE ANALYSIS

ISRAEL NUSSBAUM

NOVEMBER 1978

FINAL REPORT

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

US ARMY AVIATION RESEARCH AND DEVELOPMENT COMMAND
Directorate for Plans and Analysis
Systems and Cost Analysis Division
Developmental Systems Analysis Branch
P.O. Box 209
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Information and data contained in this document are based on input available at the time of preparation. The results are subject to change and update.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Reliability	Direct Maintenance
Availability	Indirect Maintenance
Maintainability	Scheduled Maintenance
Maintenance Ratio	Unscheduled Maintenance

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report consists of a comparative analysis of reported Maintenance Manhours per Flight Hour (MMH/FH) for a group of five (5) developmental Army helicopter systems expected to be operational in the mid-1980's time period. The study was initiated as a result of the wide disparity found among the various aircraft programs in the way MMH/FH data is obtained as well as how it is processed and displayed. There is a need for uniformity, consistency and validity in the aircraft MMH/FH projections, which form the primary basis for development of aircraft field unit TOEs. (Note: This report supersedes TR 78-30, dated May 1978, AD No. A056893)

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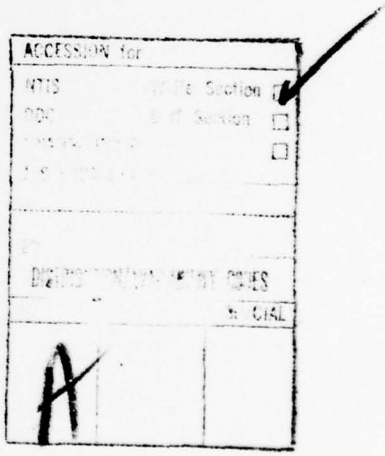

LIST OF ILLUSTRATIONS

I. PURPOSE AND SCOPE:

A. The purpose of this study is to develop and apply a set of Reliability, Availability and Maintainability (RAM) factors and criteria which will help to achieve uniformity, consistency and validity when projecting Maintenance Manhours per Flight Hour (MMH/FH) for developmental aircraft systems. The need for this study became apparent after analyzing the MMH/FH inputs to the Attack Helicopter Organization 1985 (ATHELO) Study conducted by the US Army Concepts Analysis Agency (Reference 1). These inputs manifested a wide disparity among various aircraft programs in the way MMH/FH data is obtained as well as how it is processed and displayed. Achievement of the above goals of uniformity, consistency and validity in this area will have the following beneficial results:

1. Improved force and cost estimating in various studies which have high-level interest, such as the Baseline Cost Estimate (BCE), Independent Cost Estimate (ICE), Cost and Operational Effectiveness Analysis (COEA) and the current ATHELO Study.

2. More accurate and valid construction of field level Tables of Organization and Equipment (TOE) for the purpose of study, testing and actual deployment of new aircraft systems.

B. The scope of this study is limited to analysis of maintenance performed at AVUM and AVIM support levels for the following aircraft systems: AH-64(AAH), UH-60A Black Hawk, AH-1S(MOD), OH-58C, and the Generic ASH. The time frame for application is assumed to be the same as in the ATHELO Study, the mid-1980's.

II. BACKGROUND AND DISCUSSION:

A. Estimates of MMH/FH for aircraft scheduled to be fielded form a major basis for the construction of field level TOEs. The primary sources for guidance in this area are the following:

1. AR 570-2 (Reference 2).

2. AR 611-201 (Reference 3).

3. HQ TRADOC, Org Directorate (Reference 4).

Reference 2 was used to determine the current official maintenance manhour requirements for fielded Army helicopter systems. Reference 3 contains the authorized enlisted MOS categories and description, which have recently been revised. Reference 4 contains revisions to the Manpower Authorization Criteria (MACRIT) and maintenance manhour requirements in AR 570-2.

B. Prior to the start of this effort, the MMH/FH figures for the various aircraft systems, as provided by their respective program offices, were requested for input to the ATHELO Study mentioned in paragraph I-A above. The replies obtained were displayed in a variety of formats and were based on data sources which were unclear or could be easily challenged. Figures 1-5 show the various estimates as they were received originally. All of the estimates were for direct maintenance only, although other assumptions and ground rules used were not spelled out.

FIGURE 1

AH-64 RELIABILITY, AVAILABILITY, and MAINTAINABILITY - ATHELO STUDY

1. Estimated Direct Maintenance Manhours per Flight Hour:

CATEGORY	AVUM	AVIM
Airframe	.3238	.4229
Landing Gear	.0881	.0207
Engine	.1945	.2937
Drive Train	1.0289	.1922
Hydraulics	.0658	.0229
Instruments	.0846	.1453
Electrical	.0923	.0917
Fuel	.1231	.0033
Flt Controls	.2667	.1972
Utility	.0503	.0234
APU	.0547	.0212
Avionics	.2509	1.8350
Armament	.5664	.3340
Fire Control	.4348	.5922
	3.6249	4.1957

Source: AAH COEA Input, HELLFIRE Configuration, May 1976. Rationale at that time indicated that the data was based on "actual field experience".

FIGURE 2

UH-60A BLACK HAWK MAINTENANCE REQUIREMENTS

MOS	SKILL/SPECIALITY CODE	MMH/FH (AVUM)
67T	Util Transp Helic Rpr	1.5273
68B	Powerplant Rpr	.147
68D	Powertrain Rpr	.101
68F	Electrician	.108
68G	Acft Structural Rpr	.043
68H	Pneudraulics Rpr	.0825
35K	Avionics Rpr	.1695
26K	Survivability Equip Rpr	.0089
68M	Armament Rpr	--
	TOTAL	2.1872

Source: Projection of requirements based on contractor and government inputs. Results contained in letter, PM Black Hawk to U.S. Army Infantry Center, dated 9 Nov 77.

FIGURE 3

ESTIMATED MAINTENANCE MANHOURS PER FLIGHT HOUR FOR MODERNIZED AH-1S COBRA

	Maintenance Level	
	AVUM	AVIM
Airframe	.783	.413
Landing Gear	.065	.034
Engine	.536	.282
Rotors and Transmission	.952	.501
Hydraulic System	.114	.060
Instruments	.022	.012
Electric System	.065	.034
Fuel System	.067	.035
Flight Controls	.050	.027
Utility Systems	.018	.009
Avionics	.480	.253
Armament	.986	.004
Fire Control	.042	.001
Total	4.180	1.665

Source: Rotors and Transmission (R&T) and Avionics data are based on Navy 3M reporting, with R&T adjusted for expected improvement in Improved Main Rotor Blade. Armament and Fire Control are based on predictions and requirements of the development programming with TOW Missile System data supplemented by field experience. All other data was taken from TAMMS reporting during the period June 1970 - June 1972.

FIGURE 4

OH-58C RELIABILITY, AVAILABILITY, and MAINTAINABILITY - ATHELO STUDY

1. Maintenance Manhours per flight hour (direct only):

SKILL	AVUM	AVIM
Helicopter RPR	2.30	.57
Engine RPR	.06	.04
Powertrain RPR	.09	.06
Electrician*	.03	.03
Airframe RPR	.34	.29
Hydraulic RPR	.02	.02
TOTAL	2.84	1.01

* Includes instrument repair.

NOTE: Avionics MMH/FH should be obtained from ECOM.

Source: Data contained in Qualitative and Quantitative Personnel Requirements Information (QQPRI). Originally based on TAMMS/TAERS data obtained from Vietnam during FY 72.

FIGURE 5

DIRECT MAINTENANCE MANHOURS PER FLIGHT HOUR FOR GENERIC ASH SYSTEM

CATEGORY/SUBSYSTEM	MOS	AVUM	AVIM
Airframe	68G	.60	.23
Engine	68B	.40	.15
Power Train	68D	1.00	.38
Hydraulics	68H	.20	.07
Electrical/Instruments	68F	.20	.07
Helic. General	67 Series	1.00	.38
Avionics/Flt Control	35 Series	.60	.22
Total		4.00	1.50

Source: ROC requirements and engineering estimates based on analysis of RAM/LOG data.

III. APPROACH AND METHODOLOGY:

A. During the course of this effort the estimates shown in Figures 1-5 were revised to the extent possible, in presentation format as well as amounts. The assumptions and ground rules used to obtain the new figures were more firmly defined, so that it is now at least more clear what the figures represent.

B. The basic step-by-step approach used in this study was as follows:

1. Lay out the original RAM position and status of each of the five aircraft systems listed in para I. Include the data sources and assumptions used to generate the figures, if available.[1/]

2. Determine and compile a list of key factors and criteria needed to attain uniformity, consistency and validity in the MMH/FH projections (see para III-C).

3. Work with the various project offices in an attempt to redefine and/or clarify their RAM positions based on these factors and criteria.

1/ Note: The direct relationship between RAM and MMH/FH for unscheduled maintenance on a major component at the AVUM level can be quantified by the equation: $MMH/FH = \frac{MTTR}{MTBR}$, where MTTR is Mean Time to Repair and MTBR is Mean Time Between Removals.

C. In seeking to attain the goals of uniformity, consistency and validity in the MMH/FH projections, the following factors and criteria were determined:

1. The quality and validity of data sources and estimates should be noted, with degrees of confidence provided. This should be based on consideration of the particular testing or operational environment under study, the types of failures counted, the accuracy of data recording, the number of flight hours flown, and the time period of the data.

2. Types of maintenance actions charged:

a. Both direct and indirect maintenance should be charged. If indirect is unavailable, use the standard 0.4 add-on factor.

b. Both internal (chargeable) and induced (non-chargeable) failures should be included. If only internal (chargeable) failures are provided, a factor for non-chargeable failures should be added, since these would inevitably be encountered in actual field operation.

c. Both scheduled and unscheduled maintenance should be figured, and the data should be broken out accordingly.

d. Both on and off-aircraft maintenance should be counted at AVUM and AVIM levels.

e. All productive and non-productive maintenance time should be figured. If only productive time is available, apply appropriate productivity factors.

3. Format of Task Breakout.

a. Ideal breakout - by current enlisted MOS's.

b. If MOS's are obsolete, redistribute data into current MOS's.

c. If data is broken out by subsystems or functional groups, determine relationship between these and current MOS categories (i.e., percent of time worked by the specialists on each subsystem). Then convert to MOS breakout.

IV. RESULTS TO DATE: Using the factors and criteria listed above, the project offices which provided the original data were re-contacted, and inquiry was made in an effort to improve the data. The data sources and the assumptions and ground rules used were closely questioned in order to reveal the degree of validity of the data. In addition, the project offices were asked to re-formulate their data in terms of current MOS's, where they had not done so already. The results of this effort to date are summarized below:

1. Quality and validity of data sources and estimates: Weakest area overall - no solid data base for any of the systems.

a. AH-64(AAH) - Original data submitted was the old input to the 1976 AAH COEA, which had some serious problems. The new data by functional group breakout is based on contractor testing and future projections, modified by PM estimates. (See Figure 6)

b. AH-1S(MOD) - No change in original submission. Based on combination of old (1970-72) TAMMS data, Navy 3M data, partial test results, and development program requirements.

c. OH-58C - No significant change in original submission. Based on old TAMMS data primarily from Vietnam (wartime estimates only).

d. UH-60A BLACK HAWK - No significant change in original submission. Based on program requirements as well as developmental test results and special requirements for FDTE testing.

FIGURE 6

AH-64 (AAH) RAM Data (Revised) - ATHELO Study

1. Estimated Direct MMH/FH:

Category/Subsystem	AVUM	AVIM
Airframe	.240	.912
Landing Gear	.051	.043
Engine	.086	.067
Drive Train	.743	.276
Hydraulics/Pneumatics	.104	.017
Instruments	.048	.185
Electrical	.024	.060
Fuel	.032	.017
Utility	.064	.033
APU	.047	.107
Flt Control	.127	.110
Avionics	.157	.472
Armament	.161	.209
Fire Control (incl TADS)	.026	.081
Visionics (PNVS)	.026	.042
Subtotal (Unsched.)	1.936	2.631
Sched. Maint	2.781	--
TOTAL	4.717	2.631

NOTE: Item 2, 3 and 4 on the RAM data list are unchanged since the 28 March letter.

e. Generic ASH - Original submission was revised to redistribute the manhours more appropriately, based on ROC requirements and estimates and projections from RAM/LOG data on other aircraft systems.

2. Ground rules and assumptions for types of maintenance actions charged:

a. AH-64(AAH) - Most recent PM update clearly states that data represents direct, chargeable, productive manhours. Scheduled maintenance is shown separately from unscheduled. Both on and off aircraft maintenance are included at the AVUM and AVIM levels.

b. AH-1S(MOD) - The data obtained from the PM apparently represents total on-aircraft maintenance direct and indirect. Off aircraft maintenance is omitted.

c. OH-58C - The data from the proponent office represents direct maintenance only and includes both chargeable and unchargeable maintenance actions. Further ground rules and assumptions are unclear at this point.

d. UH-60A BLACK HAWK - Same as for OH-58C above.

e. Generic ASH - Same as for OH-58C above.

3. Format of Task Breakout:

a. Nearly all of the above systems are now available in the MOS breakout format, with the exception of AVIM data for the Generic ASH. In addition, the AVIM data being used for the BLACK HAWK is based on inputs to the 1976 UTTAS COEA. New AVIM estimates for both the Generic ASH and the BLACK HAWK should be available in the near future.

b. Figure 7 shows a complete MOS breakout of all the aircraft systems under study, based on currently available data. In all cases where only direct MMH/FH was available, the values were increased by a

FIGURE 7

TOTAL (DIRECT & INDIRECT) AIRCRAFT MMH/FH by MOS

MOS	TITLE	AH-1S(MOD)[1]		AH-64(AAH)		OH-58C[1]		Generic ASH		UH-60A BLACK HAWK	
		AVUM	AVIM	AVUM	AVIM	AVUM	AVIM	AVUM	AVIM[2]	AVUM	AVIM[3]
67 Series	Helicopter Rpr[4]	5.57	1.09	5.383	--	3.71	.91	4.40		2.138	.003
68B	Powerplant Rpr	.22	.31	.052	.238	.08	.56	.08		.309	.011
68D	Power Train Rpr	.24	.28	.207	.392	.13	.08	.17		.141	.048
68F	Electrician	.06	.06	.095	.305	.04	.04	.07		.144	.067
68G	Acft Structure Rpr	.17	.32	.262	1.362	.48	.41	.21		.060[5]	.634
68H	Pneudraulics Rpr	.06	.04	.077	.182	.03	.03	.04		.115	.035
	SUB-TOTAL	6.32	2.10	6.076	2.479	4.47	2.03	4.97		2.907	0.798
68J	Missile Sys Rpr	-	-	.098	.290	-	-	-		-	-
68M	Weapon Sys Rpr	.99	.01	.200	.213	-	-	-		-	-
35 Series	Avionics/FC Equip Rpr	.52	.25	.230	.701	.56	.35	.63		.238	.413
26K	Surviv. Equip Rpr	-	-	-	-	-	-	-		.013	-
	TOTAL	7.83	2.36	6.604	3.683	5.03	2.38	5.60		3.158	1.211

1/ Obtained from Hq TRADOC, Org Directorate Bulletin No. 12-77, dated 1 December 77.
2/ Data was not available as of date of this report.
3/ Based on input to UTTAS COEA, February 1976. Currently being revised.
4/ Includes all scheduled maintenance and inspections.
5/ Although this figure implies the need for only one 68G mechanic, two will be assigned to this task upon actual deployment to Assault units.

factor of 0.4 to account for indirect maintenance. In addition, the maintenance for special mission-related equipment such as avionics or weapon systems is listed separately from the basic aircraft maintenance in order to facilitate a more valid comparative analysis.

V. FUTURE EFFORT:

A. The following data items are still missing or require further revision:

1. Current AVIM data for both BLACK HAWK and the Generic ASH are still missing, but may be available in the near future.

2. AH-1S(MOD) data broken out by functional groups and by MOS show a substantial variance in the totals, as may be observed by comparing Figures 1 and 7.

B. In addition to the above, some of the data already provided may be substantially upgraded in quality as more RAM/LOG data comes in and as a result of implementation of the Logistic Support Analysis (LSA) programs currently being developed and refined. After these two systems become fully operational and experienced, they should provide a system to accurately identify, define, analyze and process logistic support requirements that reflect the RAM characteristics as well as the mission requirements of new aircraft systems.

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